In [1]:
```
import numpy as np
import pandas as pd
import seaborn as sns
import math
import matplotlib.pyplot as plt
import scipy.stats as stats
from scipy.stats import ttest_1samp, ttest_ind, ttest_rel, chi2_contingency
from warnings import filterwarnings
filterwarnings("ignore")
```

In [2]:
```
# Problem 1

# Que1.1 a)
```

In [3]:
```
df = pd.read_csv('Wholesale Customer.csv')
df.head()
new_df = df[df.columns.difference(['Buyer/Spender'])]
df
```

Out[3]:

	Buyer/Spender	Channel	Region	Fresh	Milk	Grocery	Frozen	Detergents_Paper	Delicates
0	1	Retail	Other	12669	9656	7561	214	2674	1
1	2	Retail	Other	7057	9810	9568	1762	3293	1
2	3	Retail	Other	6353	8808	7684	2405	3516	7
3	4	Hotel	Other	13265	1196	4221	6404	507	1
4	5	Retail	Other	22615	5410	7198	3915	1777	5
...	...	...	...	...	...	...	...	...	
435	436	Hotel	Other	29703	12051	16027	13135	182	2
436	437	Hotel	Other	39228	1431	764	4510	93	2
437	438	Retail	Other	14531	15488	30243	437	14841	1
438	439	Hotel	Other	10290	1981	2232	1038	168	2
439	440	Hotel	Other	2787	1698	2510	65	477	

440 rows × 9 columns

In [4]:
```
new_df.describe()
```

Out[4]:

	Delicatessen	Detergents_Paper	Fresh	Frozen	Grocery	Milk
count	440.000000	440.000000	440.000000	440.000000	440.000000	440.000000
mean	1524.870455	2881.493182	12000.297727	3071.931818	7951.277273	5796.265909
std	2820.105937	4767.854448	12647.328865	4854.673333	9503.162829	7380.377175
min	3.000000	3.000000	3.000000	25.000000	3.000000	55.000000
25%	408.250000	256.750000	3127.750000	742.250000	2153.000000	1533.000000
50%	965.500000	816.500000	8504.000000	1526.000000	4755.500000	3627.000000
75%	1820.250000	3922.000000	16933.750000	3554.250000	10655.750000	7190.250000
max	47943.000000	40827.000000	112151.000000	60869.000000	92780.000000	73498.000000

In [5]:
```
#Que1.1 b)
```

In [6]:
```
# df['Total']= df['Fresh']+df['Milk']+df['Grocery']+df['Frozen']+df['Detergents_P
df['Total']= df.iloc[:,3:9].sum(axis =1)
```

In [7]:
```
df.groupby('Channel').agg({'Total':'sum'})
```

Out[7]:

	Total
Channel	
Hotel	7999569
Retail	6619931

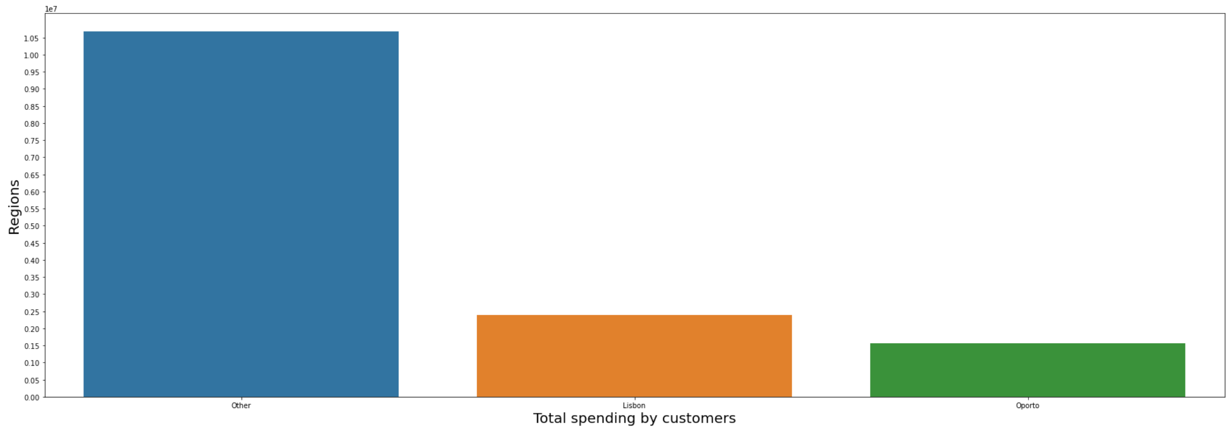
In [8]:
```
df.groupby('Region').agg({'Total':'sum'})
```

Out[8]:

	Total
Region	
Lisbon	2386813
Oporto	1555088
Other	10677599

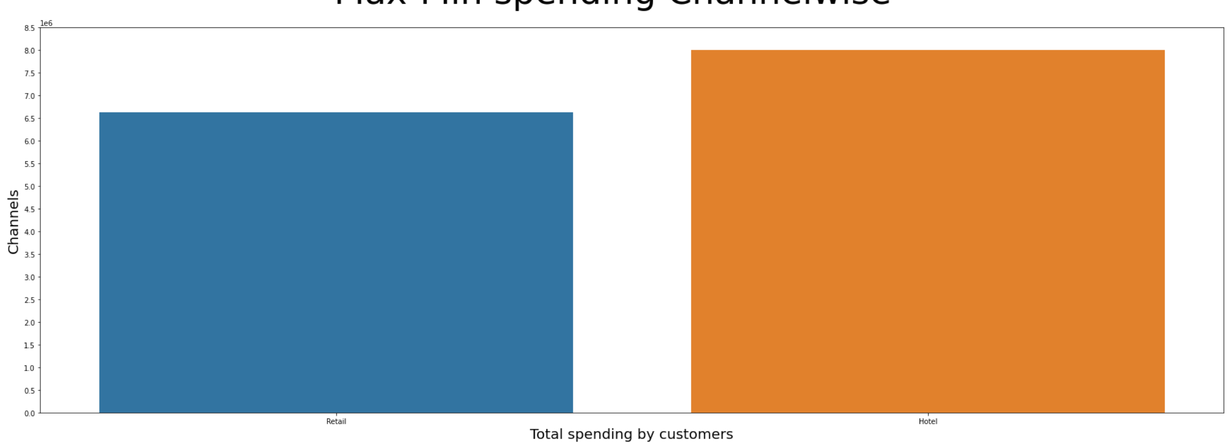
In [9]:
```
fig = plt.figure(figsize=(30,10))
fig.suptitle('Max-Min spending Regionwise', fontsize=50, ha='center')
sns.barplot(df['Region'],df['Total'],ci=None,estimator=np.sum);
plt.yticks(np.arange(0,11000000,500000))
plt.xlabel('Total spending by customers',fontsize=20)
plt.ylabel('Regions',fontsize=20)
plt.show();
```

Max-Min spending Regionwise



In [10]:
```
fig = plt.figure(figsize=(30,10))
fig.suptitle('Max-Min spending Channelwise', fontsize=50, ha='center')
sns.barplot(df['Channel'],df['Total'],ci=None,estimator=np.sum);
plt.yticks(np.arange(0,9000000,500000))
plt.xlabel('Total spending by customers',fontsize=20)
plt.ylabel('Channels',fontsize=20)
plt.show()
```

Max-Min spending Channelwise



In [11]:
```
# Que1.2
```

In [12]:
```
# df1 = df[['Channel','Fresh','Milk','Grocery','Frozen','Detergents_Paper','Delic
# df2 = df[['Region','Fresh','Milk','Grocery','Frozen','Detergents_Paper','Delica
df1 = df.iloc[:,1:9]
df2 = df.iloc[:,2:9]
```

In [13]:
```
df1.groupby('Channel').describe().transpose()
df1
```

Out[13]:

	Channel	Region	Fresh	Milk	Grocery	Frozen	Detergents_Paper	Delicatessen
0	Retail	Other	12669	9656	7561	214	2674	1338
1	Retail	Other	7057	9810	9568	1762	3293	1776
2	Retail	Other	6353	8808	7684	2405	3516	7844
3	Hotel	Other	13265	1196	4221	6404	507	1788
4	Retail	Other	22615	5410	7198	3915	1777	5185
...	...	...	...	...	...	...	...	...
435	Hotel	Other	29703	12051	16027	13135	182	2204
436	Hotel	Other	39228	1431	764	4510	93	2346
437	Retail	Other	14531	15488	30243	437	14841	1867
438	Hotel	Other	10290	1981	2232	1038	168	2125
439	Hotel	Other	2787	1698	2510	65	477	52

440 rows × 8 columns

In [14]:
```
df2.groupby('Region').describe().transpose()
```

Out[14]:

	Region	Lisbon	Oporto	Other
Fresh	**count**	77.000000	47.000000	316.000000
	mean	11101.727273	9887.680851	12533.471519
	std	11557.438575	8387.899211	13389.213115
	min	18.000000	3.000000	3.000000
	25%	2806.000000	2751.500000	3350.750000
	50%	7363.000000	8090.000000	8752.500000
	75%	15218.000000	14925.500000	17406.500000
	max	56083.000000	32717.000000	112151.000000
Milk	**count**	77.000000	47.000000	316.000000
	mean	5486.415584	5088.170213	5977.085443
	std	5704.856079	5826.343145	7935.463443
	min	258.000000	333.000000	55.000000
	25%	1372.000000	1430.500000	1634.000000
	50%	3748.000000	2374.000000	3684.500000
	75%	7503.000000	5772.500000	7198.750000
	max	28326.000000	25071.000000	73498.000000
Grocery	**count**	77.000000	47.000000	316.000000
	mean	7403.077922	9218.595745	7896.363924
	std	8496.287728	10842.745314	9537.287778
	min	489.000000	1330.000000	3.000000
	25%	2046.000000	2792.500000	2141.500000
	50%	3838.000000	6114.000000	4732.000000
	75%	9490.000000	11758.500000	10559.750000
	max	39694.000000	67298.000000	92780.000000
Frozen	**count**	77.000000	47.000000	316.000000
	mean	3000.337662	4045.361702	2944.594937
	std	3092.143894	9151.784954	4260.126243
	min	61.000000	131.000000	25.000000
	25%	950.000000	811.500000	664.750000
	50%	1801.000000	1455.000000	1498.000000
	75%	4324.000000	3272.000000	3354.750000
	max	18711.000000	60869.000000	36534.000000
Detergents_Paper	**count**	77.000000	47.000000	316.000000
	mean	2651.116883	3687.468085	2817.753165

	Region	Lisbon	Oporto	Other
	std	4208.462708	6514.717668	4593.051613
	min	5.000000	15.000000	3.000000
	25%	284.000000	282.500000	251.250000
	50%	737.000000	811.000000	856.000000
	75%	3593.000000	4324.500000	3875.750000
	max	19410.000000	38102.000000	40827.000000
Delicatessen	**count**	77.000000	47.000000	316.000000
	mean	1354.896104	1159.702128	1620.601266
	std	1345.423340	1050.739841	3232.581660
	min	7.000000	51.000000	3.000000
	25%	548.000000	540.500000	402.000000
	50%	806.000000	898.000000	994.000000
	75%	1775.000000	1538.500000	1832.750000
	max	6854.000000	5609.000000	47943.000000

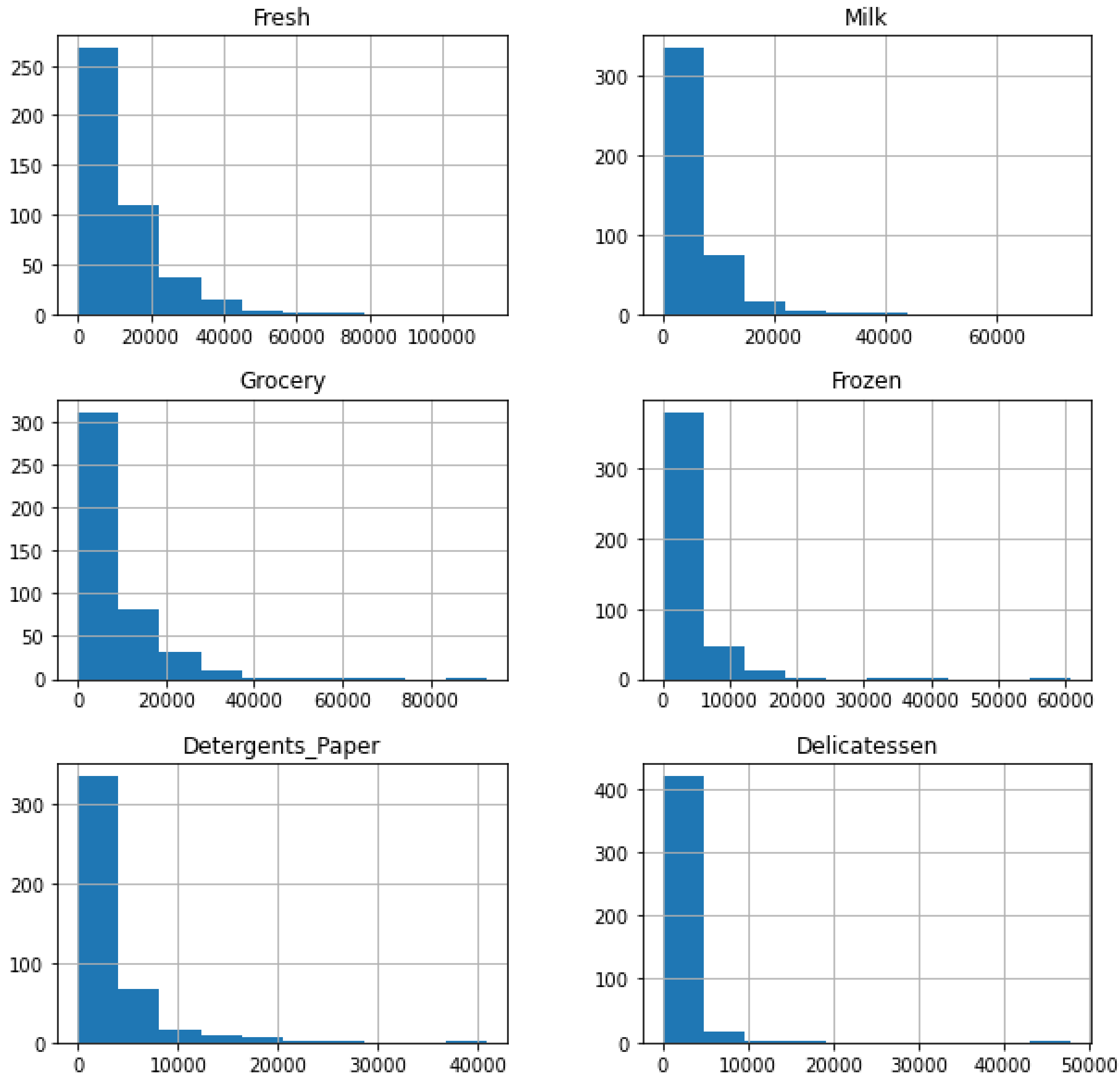
In [15]:
```
df2.cov()
#To determine the covariance between combinations of all varieties, 2 at a time.
```

Out[15]:

	Fresh	Milk	Grocery	Frozen	Detergents_Paper	D
Fresh	1.599549e+08	9.381789e+06	-1.424713e+06	2.123665e+07	-6.147826e+06	8.
Milk	9.381789e+06	5.446997e+07	5.108319e+07	4.442612e+06	2.328834e+07	8.
Grocery	-1.424713e+06	5.108319e+07	9.031010e+07	-1.854282e+06	4.189519e+07	5.
Frozen	2.123665e+07	4.442612e+06	-1.854282e+06	2.356785e+07	-3.044325e+06	5.
Detergents_Paper	-6.147826e+06	2.328834e+07	4.189519e+07	-3.044325e+06	2.273244e+07	9.
Delicatessen	8.727310e+06	8.457925e+06	5.507291e+06	5.352342e+06	9.316807e+05	7.

In [16]:
```
# Que1.3
```

In [17]:
```
df1.hist(figsize=(10,10));
```



In [18]:
```
skewness = df1.skew(skipna=True)
skewness
```

Out[18]:
```
Fresh                2.561323
Milk                 4.053755
Grocery              3.587429
Frozen               5.907986
Detergents_Paper     3.631851
Delicatessen        11.151586
dtype: float64
```

In [19]:
```
df_3 = df.iloc[:,3:9].transpose()
iqr = stats.iqr(df_3,axis=1)
```

In [20]:
```
ind = df_3.index.values
df_3[['IQR']]=iqr
df_3['IQR'].to_frame()
```

Out[20]:

	IQR
Fresh	13806.00
Milk	5657.25
Grocery	8502.75
Frozen	2812.00
Detergents_Paper	3665.25
Delicatessen	1412.00

In [21]:
```
df1.groupby('Channel').std()
```

Out[21]:

Channel	Fresh	Milk	Grocery	Frozen	Detergents_Paper	Delicatessen
Hotel	13831.687502	4352.165571	3545.513391	5643.912500	1104.093673	3147.426922
Retail	8987.714750	9679.631351	12267.318094	1812.803662	6291.089697	1953.797047

In [22]:
```
df2.groupby('Region').std()
```

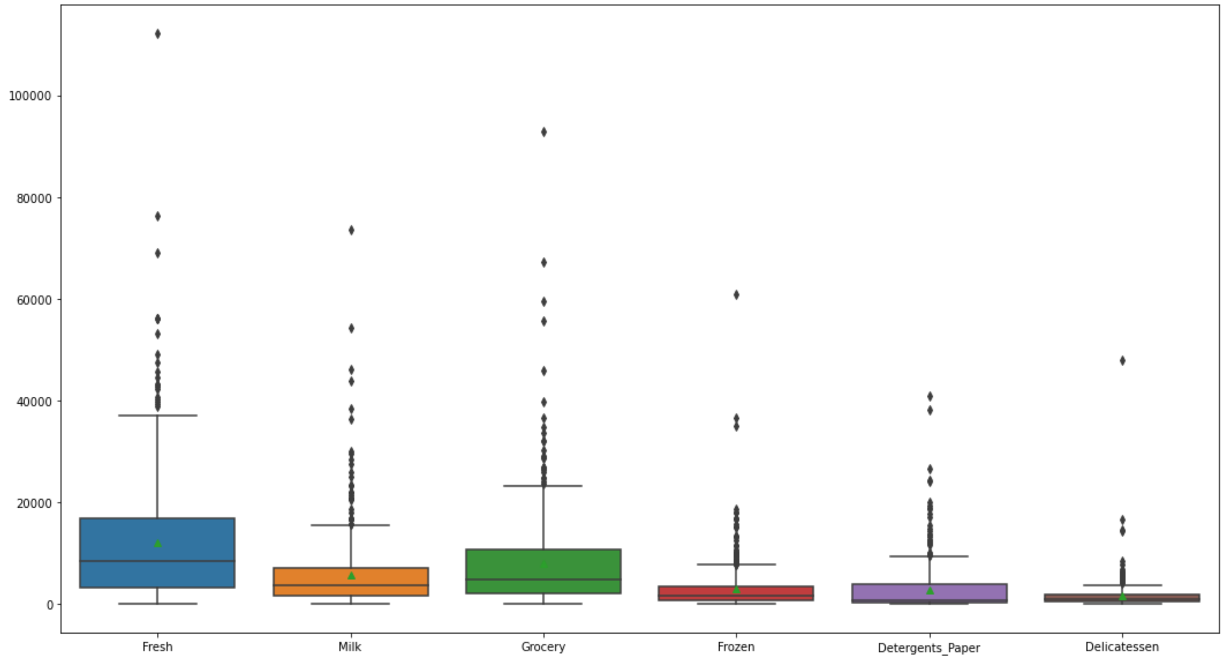
Out[22]:

Region	Fresh	Milk	Grocery	Frozen	Detergents_Paper	Delicatessen
Lisbon	11557.438575	5704.856079	8496.287728	3092.143894	4208.462708	1345.423340
Oporto	8387.899211	5826.343145	10842.745314	9151.784954	6514.717668	1050.739841
Other	13389.213115	7935.463443	9537.287778	4260.126243	4593.051613	3232.581660

In [23]:
```
# Que1.3
```

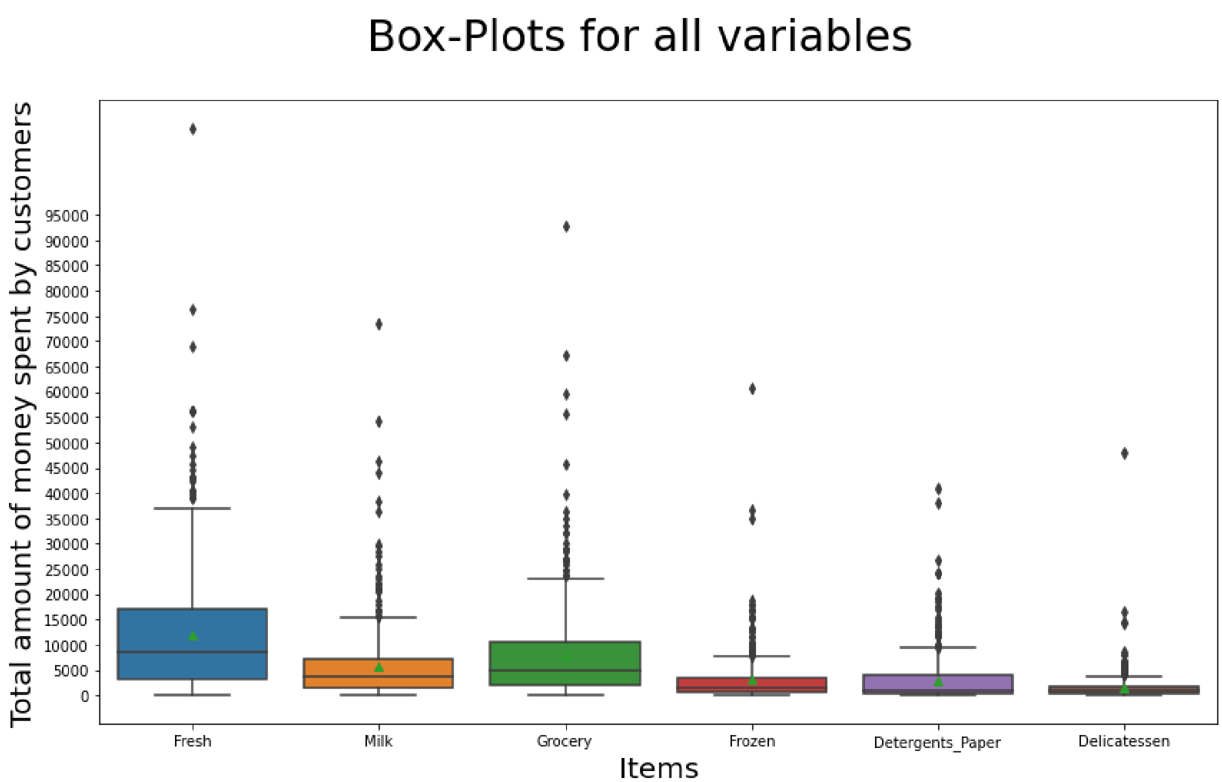
In [24]:
```
plt.figure(figsize=(18,10))
sns.boxplot(data = df1,showmeans=True)
```

Out[24]: <AxesSubplot:>



In [25]:
```
fig = plt.figure(figsize=(14,8))
fig.suptitle('Box-Plots for all variables', fontsize=30, ha='center')
plt.yticks(np.arange(0,100000,5000))
plt.xlabel('Items',fontsize=20)
plt.ylabel('Total amount of money spent by customers',fontsize=20)
sns.boxplot(data = df2,showmeans=True)
```

Out[25]:
```
<AxesSubplot:xlabel='Items', ylabel='Total amount of money spent by customers'>
```



In [26]:
```
IQR_criteria = df_3['IQR'] *1.5
IQR_criteria
```

Out[26]:
```
Fresh               20709.000
Milk                 8485.875
Grocery             12754.125
Frozen               4218.000
Detergents_Paper     5497.875
Delicatessen         2118.000
Name: IQR, dtype: float64
```

In [27]:
```
Max_Values = df.iloc[:,3:9].max()
Max_Values
```

Out[27]:
```
Fresh               112151
Milk                 73498
Grocery              92780
Frozen               60869
Detergents_Paper     40827
Delicatessen         47943
dtype: int64
```

In [28]:
```
Min_Values = df.iloc[:,3:9].min()
Min_Values
```

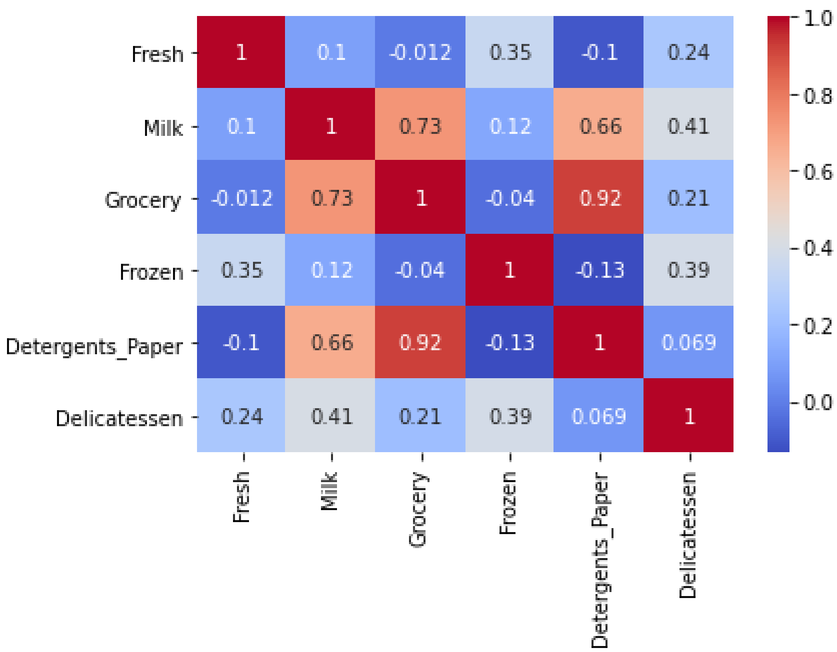
Out[28]:
```
Fresh                3
Milk                55
Grocery              3
Frozen              25
Detergents_Paper     3
Delicatessen         3
dtype: int64
```

In [29]:
```
df_corr = df.iloc[:,3:9].corr(method ='pearson')
df_corr
```

Out[29]:

	Fresh	Milk	Grocery	Frozen	Detergents_Paper	Delicatessen
Fresh	1.000000	0.100510	-0.011854	0.345881	-0.101953	0.244690
Milk	0.100510	1.000000	0.728335	0.123994	0.661816	0.406368
Grocery	-0.011854	0.728335	1.000000	-0.040193	0.924641	0.205497
Frozen	0.345881	0.123994	-0.040193	1.000000	-0.131525	0.390947
Detergents_Paper	-0.101953	0.661816	0.924641	-0.131525	1.000000	0.069291
Delicatessen	0.244690	0.406368	0.205497	0.390947	0.069291	1.000000

In [30]:
```
sns.heatmap(df_corr,annot=True , cmap='coolwarm');
```



In [31]:
```
# Problem 2
```

In [32]:
```
# Que2.1
mydata = pd.read_csv('Survey-1.csv')
mydata.head()
```

Out[32]:

	ID	Gender	Age	Class	Major	Grad Intention	GPA	Employment	Salary	Social Networking	Satis
0	1	Female	20	Junior	Other	Yes	2.9	Full-Time	50.0	1	
1	2	Male	23	Senior	Management	Yes	3.6	Part-Time	25.0	1	
2	3	Male	21	Junior	Other	Yes	2.5	Part-Time	45.0	2	
3	4	Male	21	Junior	CIS	Yes	2.5	Full-Time	40.0	4	
4	5	Male	23	Senior	Other	Undecided	2.8	Unemployed	40.0	2	

In [33]:
```
ct_1 = pd.crosstab(mydata['Gender'],mydata['Major'],margins=True)
ct_2 = pd.crosstab(mydata['Gender'],mydata['Grad Intention'],margins=True)
ct_3 = pd.crosstab(mydata['Gender'],mydata['Employment'],margins=True)
ct_4 = pd.crosstab(mydata['Gender'],mydata['Computer'],margins=True)
```

In [34]:
```
TotalCount = len(mydata)
TotalCount
```

Out[34]: 62

In [35]:
```
# Que2.2
```

In [36]:
```
# Males = mydata[mydata['Gender']=='Male'].index
MaleCount = ct_1['All']['Male']
MaleCount
```

Out[36]: 29

In [37]:
```
FemaleCount = ct_1['All']['Female']
FemaleCount
```

Out[37]: 33

In [38]:
```
#Que 2.2.1.
```

In [39]:
```
Prob_Male = MaleCount/TotalCount
Prob_Male
```

Out[39]: 0.46774193548387094

In [40]:
```
#Que 2.2.2.
```

In [41]:
```
Prob_Female = FemaleCount/TotalCount
Prob_Female
```

Out[41]: 0.532258064516129

In [42]:
```
# Que2.3 : Male
```

In [43]:
```
ct_1
```

Out[43]:

Major	Accounting	CIS	Economics/Finance	International Business	Management	Other	Retailing/Marketing
Gender							
Female	3	3	7	4	4	3	9
Male	4	1	4	2	6	4	5
All	7	4	11	6	10	7	14

In [44]:
```
Prob_MaleAccounting = ct_1['Accounting']['Male'] / MaleCount
Prob_MaleAccounting
```

Out[44]: 0.13793103448275862

In [45]:
```
Prob_MaleCIS = ct_1['CIS']['Male'] / MaleCount
Prob_MaleCIS
```

Out[45]: 0.034482758620689655

In [46]:
```
Prob_MaleEconomics_Finance = ct_1['Economics/Finance']['Male'] / MaleCount
Prob_MaleEconomics_Finance
```

Out[46]: 0.13793103448275862

In [47]:
```
Prob_MaleInternationalBusiness = ct_1['International Business']['Male'] / MaleCou
Prob_MaleInternationalBusiness
```

Out[47]: 0.06896551724137931

In [48]:
```
Prob_MaleManagement = ct_1['Management']['Male'] / MaleCount
Prob_MaleManagement
```

Out[48]: 0.20689655172413793

In [49]:
```
Prob_MaleOther = ct_1['Other']['Male'] / MaleCount
Prob_MaleOther
```

Out[49]: 0.13793103448275862

In [50]:
```
Prob_MaleRetailing_Marketing = ct_1['Retailing/Marketing']['Male'] / MaleCount
Prob_MaleRetailing_Marketing
```

Out[50]: 0.1724137931034483

In [51]:
```
Prob_MaleUndecided = ct_1['Undecided']['Male'] / MaleCount
Prob_MaleUndecided
```

Out[51]: 0.10344827586206896

In [52]:
```
# Que2.3 : Female
```

In [53]:
```
Prob_FemaleAccounting = ct_1['Accounting']['Female'] / FemaleCount
Prob_FemaleAccounting
```

Out[53]: 0.09090909090909091

In [54]:
```
Prob_FemaleCIS = ct_1['CIS']['Female'] / FemaleCount
Prob_FemaleCIS
```

Out[54]: 0.09090909090909091

In [55]:
```
Prob_FemaleEconomics_Finance = ct_1['Economics/Finance']['Female'] / FemaleCount
Prob_FemaleEconomics_Finance
```

Out[55]: 0.21212121212121213

In [56]:
```
Prob_FemaleInternationalBusiness = ct_1['International Business']['Female'] / Fer
Prob_FemaleInternationalBusiness
```

Out[56]: 0.12121212121212122

In [57]:
```
Prob_FemaleManagement = ct_1['Management']['Female'] / FemaleCount
Prob_FemaleManagement
```

Out[57]: 0.12121212121212122

In [58]:
```
Prob_FemaleOther = ct_1['Other']['Female'] / FemaleCount
Prob_FemaleOther
```

Out[58]: 0.09090909090909091

In [59]:
```
Prob_FemaleRetailing_Marketing = ct_1['Retailing/Marketing']['Female'] / FemaleCo
Prob_FemaleRetailing_Marketing
```

Out[59]: 0.2727272727272727

In [60]:
```
Prob_FemaleUndecided = ct_1['Undecided']['Female'] / FemaleCount
Prob_FemaleUndecided
```

Out[60]: 0.0

In [61]:
```
# Que2.4
```

In [62]:
```
Prob_Male_IntendsToGraduate = Prob_Male*(1-Prob_MaleUndecided)
round(Prob_Male_IntendsToGraduate*100,4)
```

Out[62]: 41.9355

In [63]:
```
ct_4
```

Out[63]:

Computer	Desktop	Laptop	Tablet	All
Gender				
Female	2	29	2	33
Male	3	26	0	29
All	5	55	2	62

In [64]:
```
Prob_FemaleHavingNoLaptop = 4/33
Prob_FemaleAndNoLaptop = Prob_Female * Prob_FemaleHavingNoLaptop
Prob_FemaleAndNoLaptop
```

Out[64]: 0.06451612903225806

In [65]:
```
# Que2.5 a)
```

In [66]:
```
ct_3
```

Out[66]:

Employment	Full-Time	Part-Time	Unemployed	All
Gender				
Female	3	24	6	33
Male	7	19	3	29
All	10	43	9	62

In [67]:
```
Prob_FullTime = 10/62
Prob_MaleAndFullTime = 7/62
Prob_MaleOrFullTime = Prob_Male + Prob_FullTime - Prob_MaleAndFullTime
Prob_MaleOrFullTime
```

Out[67]: 0.5161290322580645

In [68]:
```
# Que2.5 b)
ct_1
```

Out[68]:

Major	Accounting	CIS	Economics/Finance	International Business	Management	Other	Retailing/Marketing
Gender							
Female	3	3	7	4	4	3	(
Male	4	1	4	2	6	4	!
All	7	4	11	6	10	7	14

In [69]:
```
Prob_FemaleInternationalBusiness
```
Out[69]: 0.12121212121212122

In [70]:
```
Prob_FemaleManagement
```
Out[70]: 0.12121212121212122

In [71]:
```
Prob_InternationalBusinessOrManagementANDProb_Female = 8/62
Prob_InternationalBusinessORManagementGivenFemale = Prob_InternationalBusinessOrM
Prob_InternationalBusinessORManagementGivenFemale
```
Out[71]: 0.24242424242424243

In [72]:
```
# Que2.6
```

In [73]:
```
# create a subset of data and then use it in the cross-tab function as required.
mydata_new = mydata[mydata['Grad Intention']!= 'Undecided']
```

In [74]:
```
ct_5 = pd.crosstab(mydata_new['Gender'],mydata_new['Grad Intention'],margins=True
ct_5
```
Out[74]:

Grad Intention	No	Yes	All
Gender			
Female	9	11	20
Male	3	17	20
All	12	28	40

In [75]:
```
Prob_GradIntention = 28/40
Prob_Female_new = 20/40
Prob_FemaleAndGrad_marginal = 11/40
# For independent events, P(A n B) = P(A) * P(B)
Prob_FemaleAndGrad = Prob_Female_new * Prob_GradIntention
Prob_FemaleAndGrad
```
Out[75]: 0.35

In [76]:
```
Prob_FemaleAndGrad_marginal
#Hence, graduate intention and being female are not independent events
```
Out[76]: 0.275

In [77]:
```
# Que2.7 a)
```

In [78]:
```
CountOfGpaLessThan3 = len(mydata[mydata['GPA']<3])
CountOfGpaLessThan3
```
Out[78]: 17

In [79]:
```
ProbOfGpaLessThan3 = CountOfGpaLessThan3/TotalCount
ProbOfGpaLessThan3
```

Out[79]: 0.27419354838709675

In [80]:
```
# Que2.7 b)
```

In [81]:
```
mydata1 = mydata[mydata['Salary']>=50]
```

In [82]:
```
ct_6 = pd.crosstab(mydata1['Gender'],mydata1['Salary'],margins=True)
ct_6
```

Out[82]:

Salary	50.0	52.0	54.0	55.0	60.0	65.0	70.0	78.0	80.0	All
Gender										
Female	5	0	0	5	5	0	1	1	1	18
Male	4	1	1	3	3	1	0	0	1	14
All	9	1	1	8	8	1	1	1	2	32

In [83]:
```
ProbOfRandomMaleBeingSelected_Given50OrMoreSalary = 14/32
```

In [84]:
```
ProbOfRandomFemaleBeingSelected_Given50OrMoreSalary = 18/32
```

In [85]:
```
ProbOfRandomMaleBeingSelected = Prob_Male
```

In [86]:
```
ProbOfRandomFemaleBeingSelected = Prob_Female
```

In [87]:
```
# Que2.8
```

In [88]:
```
mydata_new = mydata[['GPA','Salary','Spending','Text Messages']]
mydata_new.describe()
```

Out[88]:

	GPA	Salary	Spending	Text Messages
count	62.000000	62.000000	62.000000	62.000000
mean	3.129032	48.548387	482.016129	246.209677
std	0.377388	12.080912	221.953805	214.465950
min	2.300000	25.000000	100.000000	0.000000
25%	2.900000	40.000000	312.500000	100.000000
50%	3.150000	50.000000	500.000000	200.000000
75%	3.400000	55.000000	600.000000	300.000000
max	3.900000	80.000000	1400.000000	900.000000

In [89]:
```
mydata_new.cov()
```

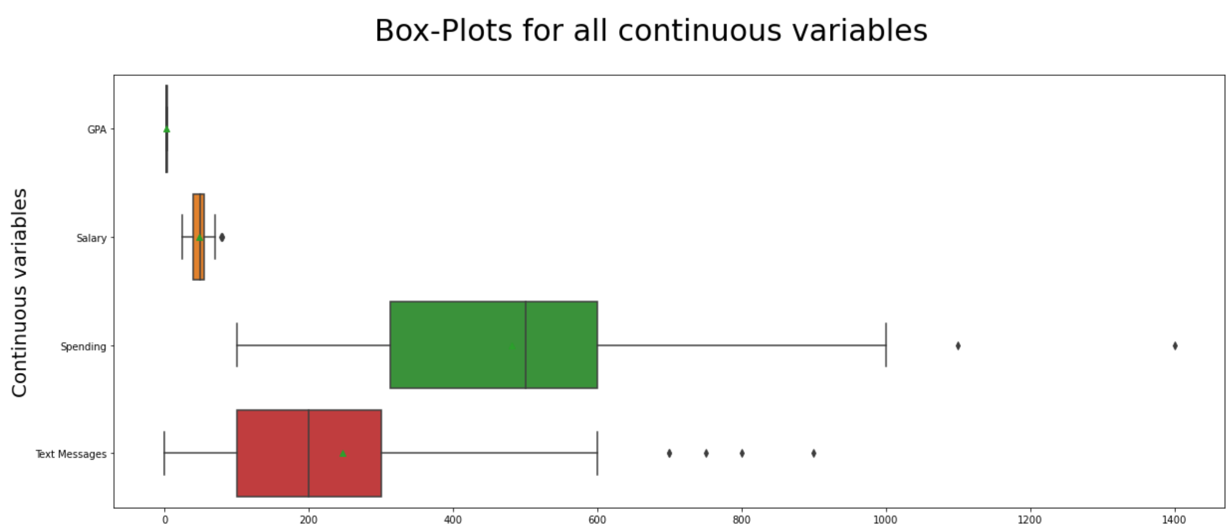
Out[89]:

	GPA	Salary	Spending	Text Messages
GPA	0.142422	-1.407166	-28.764410	3.415124
Salary	-1.407166	145.948440	9.122158	-190.797197
Spending	-28.764410	9.122158	49263.491539	1356.127710
Text Messages	3.415124	-190.797197	1356.127710	45995.643839

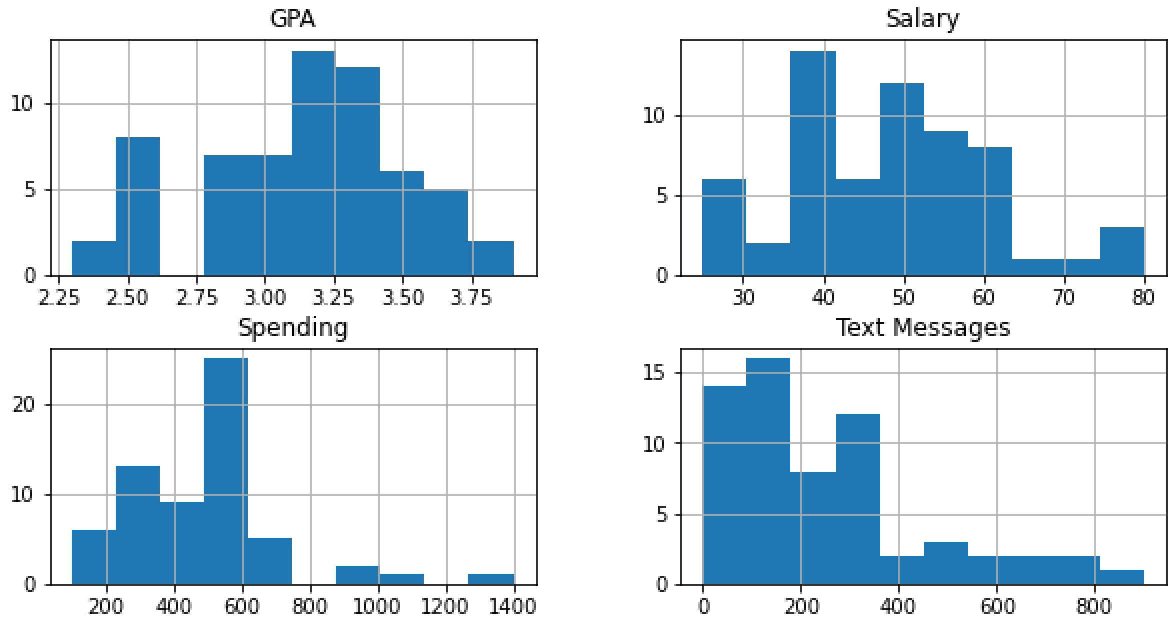
In [90]:
```
skewness = mydata_new.skew()
print('Skewness :\n',skewness)
```

```
Skewness :
 GPA              -0.314600
Salary            0.534701
Spending          1.585915
Text Messages     1.295808
dtype: float64
```

In [91]:
```
fig = plt.figure(figsize=(20,8))
fig.suptitle('Box-Plots for all continuous variables', fontsize=30, ha='center')
plt.ylabel('Continuous variables',fontsize=20)
sns.boxplot(data = mydata_new,orient='h',showmeans=True);
```



In [92]:
```
mydata_new.hist(figsize=(10,5));
```



In [93]:
```
mydata_new.mean()
```

Out[93]:
```
GPA                3.129032
Salary            48.548387
Spending         482.016129
Text Messages    246.209677
dtype: float64
```

In [94]:
```
mydata_new.median()
```

Out[94]:
```
GPA                3.15
Salary            50.00
Spending         500.00
Text Messages    200.00
dtype: float64
```

In [95]:
```
mydata_new.mode()
```

Out[95]:

	GPA	Salary	Spending	Text Messages
0	3.0	40.0	500.0	300.0
1	3.1	NaN	NaN	NaN
2	3.4	NaN	NaN	NaN

In [96]:
```
# Problem 3
# Que3.1
```

In [97]:
```
data = pd.read_csv('A & B shingles.csv')
data.head()
```

Out[97]:

	A	B
0	0.44	0.14
1	0.61	0.15
2	0.47	0.31
3	0.30	0.16
4	0.15	0.37

In [98]:
```
data.describe()
```

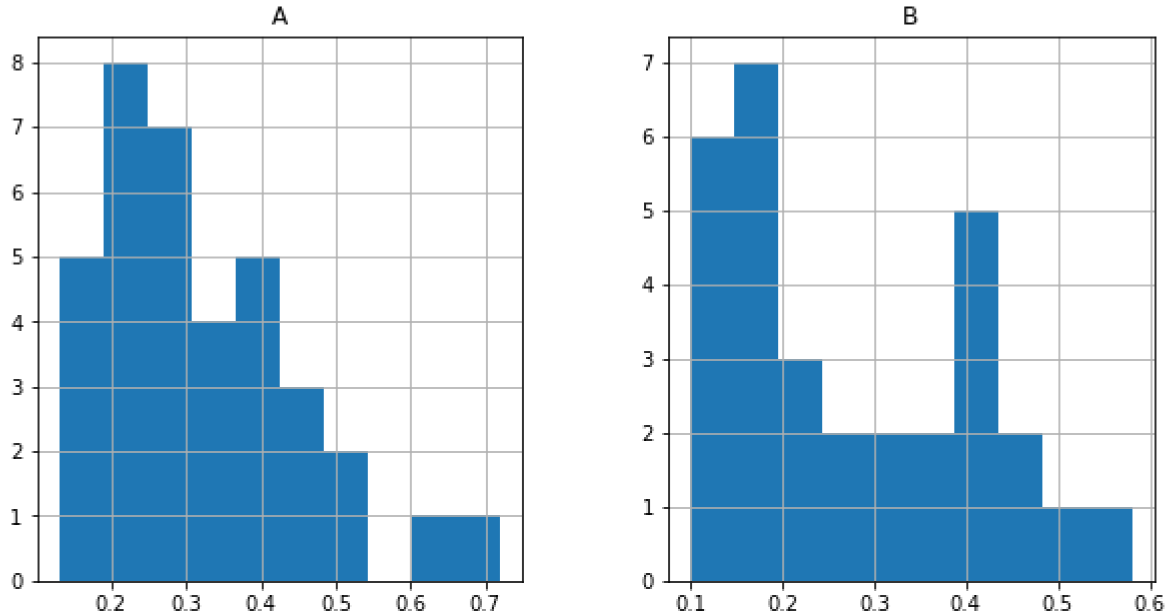
Out[98]:

	A	B
count	36.000000	31.000000
mean	0.316667	0.273548
std	0.135731	0.137296
min	0.130000	0.100000
25%	0.207500	0.160000
50%	0.290000	0.230000
75%	0.392500	0.400000
max	0.720000	0.580000

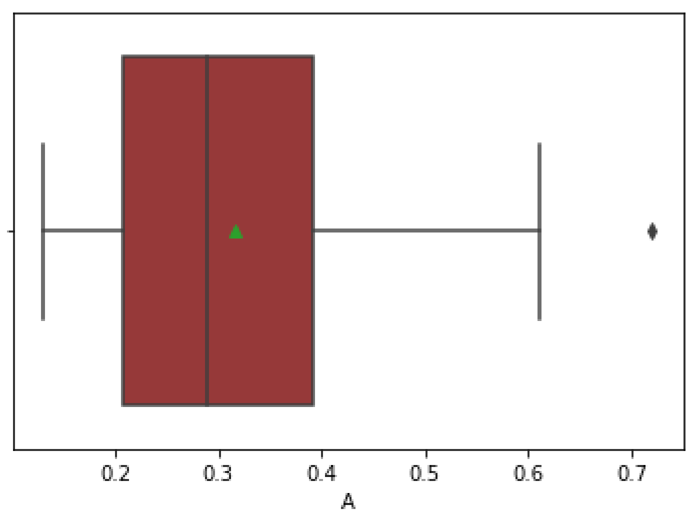
In [99]:
```
data.isnull().sum()
# There are 5 missing values in Column 'B' of the dataset provided.
```

Out[99]:
```
A    0
B    5
dtype: int64
```

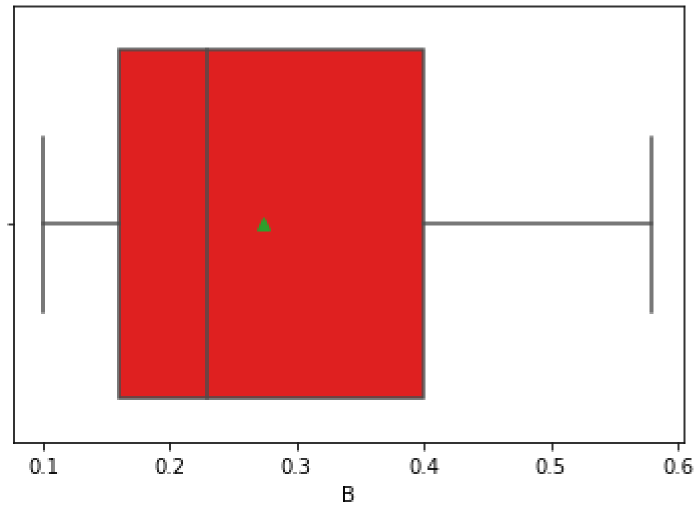
In [100]:
```
data.hist(figsize=(10,5));
```



In [101]:
```
sns.boxplot(x=data['A'],color='brown',showmeans =True);
```



In [102]:
```
sns.boxplot(x=data['B'],color='red',showmeans =True);
```



In [103]:
```
PopMean = 0.35
```

In [104]:
```
m1 = data['A'].mean()
m1
```

Out[104]:
```
0.31666666666666666
```

In [105]:
```
stdev1 = data['A'].std()
stdev1
```

Out[105]:
```
0.13573082605973166
```

In [106]:
```
m2 = data['B'].mean()
m2
```

Out[106]:
```
0.2735483870967742
```

In [107]:
```
stdev2 = data['B'].std()
stdev2
```

Out[107]:
```
0.13729647694185443
```

For Sample : A

Step 1: Define null and alternative hypotheses

Null hypothesis states that mean moisture content μ =< 0.35

Alternative hypothesis states that the mean moisture content μ > 0.35

$H0$: μ =< 0.35 HA : μ > 0.35

Step 2: Decide the significance level

Here we select α = 0.05

Step 3: Identify the test statistic

In [108]:

```
t_statistic, p_value  =  stats.ttest_1samp(data['A'],PopMean,nan_policy='omit')
print('tstat  %1.3f' % t_statistic)
print("p-value for one-tail  %1.3f" % p_value)
```

```
tstat  -1.474
p-value for one-tail  0.150
```

In [109]:

```
# p_value > 0.05 => failed to reject Null hypothesis
alpha_value = 0.05
print('Level of significance: %.2f' %alpha_value)
if p_value < alpha_value:
    print('We have evidence to reject the null hypothesis since p value < Level o
else:
    print('We have no evidence to reject the null hypothesis since p value > Leve

print ("Our one-sample t-test p-value=", p_value/2)
```

```
Level of significance: 0.05
We have no evidence to reject the null hypothesis since p value > Level of sign
ificance
Our one-sample t-test p-value= 0.07477633144907513
```

For Sample : B

Step 1: Define null and alternative hypotheses

Null hypothesis states that mean moisture content μ =< 0.35

Alternative hypothesis states that the mean moisture content μ > 0.35

$H0$: μ =< 0.35 HA : μ > 0.35

Step 2: Decide the significance level

The level of significance (Alpha) = 0.05.

Step 3: Identify the test statistic

In [110]:
```
t_statistic, p_value  =  stats.ttest_1samp(data['B'],PopMean,nan_policy='omit')
print('tstat  ',t_statistic)
print('p-value for one-tail  ', (p_value/2))
```

```
tstat   -3.1003313069986995
p-value for one-tail   0.0020904774003191826
```

In [111]:
```
# p_value < 0.05 => Rejected Null hypothesis
alpha_value = 0.05
print('Level of significance: %.2f' %alpha_value)
if p_value < alpha_value:
    print('We have evidence to reject the null hypothesis since p value < Level c
else:
    print('We have no evidence to reject the null hypothesis since p value > Leve

print ("Our one-sample t-test p-value=", p_value/2)
```

```
Level of significance: 0.05
We have evidence to reject the null hypothesis since p value < Level of signifi
cance
Our one-sample t-test p-value= 0.0020904774003191826
```

In [112]:
```
# Que3.2
```

Step 1: Define null and alternative hypotheses

Null hypothesis states that the population mean moisture content for A & B are equal

Alternative hypothesis states that the mean moisture content for A & B are not equal μ(A) ≠ μ(B)

$H0$: μ(A) = μ(B) HA : μ(A) ≠ μ(B)

Step 2: Decide the significance level

The level of significance (Alpha) = 0.05.

Step 3: Identify the test statistic

- We have two samples and we do not know the population standard deviation.
- The sample is not a large sample, n < 30. So you use the t distribution and the $tSTAT$ test statistic for two sample unpaired test.

Step 4: Calculate the p - value and test statistic

- We use the scipy.stats.ttest_ind to calculate the t-test for the means of TWO INDEPENDENT samples of scores given the two sample observations. This function returns t statistic and two-tailed p value.
- This is a two-sided test for the null hypothesis that 2 independent samples have identical average (expected) values. This test assumes that the populations have identical variances.
- For this exercise, we are going to first assume that the variance is equal and then compute the necessary statistical values.

In [113]:
```
t_statistic, p_value  = ttest_ind(data['A'],data['B'],nan_policy='omit')
print('tstat',t_statistic)
print('p-value',p_value)
```

```
tstat 1.2896282719661123
p-value 0.2017496571835306
```

Step 5: Decide to reject or accept null hypothesis

In [114]:
```
print ("two-sample t-test p-value=", p_value)

alpha_level = 0.05

if p_value < alpha_level:
    print('We have enough evidence to reject the null hypothesis in favour of alt
    print('We conclude that the mean time to deliver luggages in of both the wing
else:
    print('We do not have enough evidence to reject the null hypothesis in favour
    print('We conclude that the population mean for shingles A and B are equal')
```

```
two-sample t-test p-value= 0.2017496571835306
We do not have enough evidence to reject the null hypothesis in favour of alter
native hypothesis
We conclude that the population mean for shingles A and B are equal
```